REMARKS

The Applicants have studied the Office Action dated January 6, 2004 and have made amendments to the claims to more distinctly claim and particularly point out the subject matter which the Applicants regard as the invention. No new matter has been added by these amendments. Applicant respectfully requests entry of this amendment under the provisions of 37 C.F.R. § 1.116(a) in that the amendment and remarks below place the application and claims in condition for allowance, or, at least, present the application in better form for appeal. It is submitted that the application, as amended, is in condition for allowance. By virtue of this amendment, claims 1-26 are pending. Reconsideration and allowance of the pending claims in view of the above amendments and the following remarks is respectfully requested.

In the Office Action, the Examiner:

(5)   accepted the drawings for examination purposes;

(6)   noted the IDS is in compliance with the provisions of 37 C.F.R. 1.97;

(7-16) rejected claims 1-25 under 35 U.S.C. §102(e) as being anticipated by Kazar et al (U.S. Pub No. 2002/011022); and

(17-19) rejected claim 26 under 35 U.S.C. §102(e) as being anticipated by Lewis et al (U.S. Pub No. 2002/0083037).

Telephone Interview

As an initial matter, the Applicants wish to thank Examiner Channavajjala for holding a telephone interview on Friday, March 4, 2005, with the Applicants' attorney to discuss interpretation and construction of the elements of the independent claims in the subject application. In this telephone interview, the Examiner expressed an interpretation for the pending independent claims that covers file system volume "clones," as disclosed in the Kazar reference, that copy all inodes and share all data and indirect blocks. The problem of using volume inode "clones," as taught by Kazar, where multiple inodes all point to a particular data block was further discussed in this telephone interview. The advantages provided by the present invention that obviate the use of such "clone"

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inodes was further discussed in the telephone interview. The Applicants have amended the pending claims to more clearly describe the claimed invention in light of the issues discussed in that telephone interview.

Claim Amendments

The Applicants have amended independent claims 1, 7, 13 and 19 to more clearly describe some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 18, lines 6-18; page 20, line 19 to page 21, line 19; page 28, lines 16-24 and page 34: lines 4-26. No new matter has been added by these amendments.

The Applicants have amended dependent claims 2, 8 and 14 to more clearly define some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 24, lines 1-11. No new matter has been added by these amendments.

The Applicants have amended dependent claims 3, 9 and 15 to more clearly define some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 21, line 21 to page 22, line 7. No new matter has been added by these amendments.

The Applicants have amended dependent claims 4, 10 and 16 to more clearly define some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 30, lines 4-12, page 12, line 27 to page 13, 11. No new matter has been added by these amendments.

The Applicants have amended dependent claims 5, 11 and 17 to more clearly define some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 22, lines 9-17. No new matter has been added by these amendments.

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The Applicants have amended dependent claims 6, 12 and 18 to more clearly define some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 29, lines 10-19. No new matter has been added by these amendments.

The Applicants have amended independent claims 23 and 24 to more clearly describe some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 28, lines 16-24; page 34, lines 4-26; and page 35, line 24 to page 36, line 13. No new matter has been added by these amendments.

The Applicants have amended independent claim 26 to more clearly describe some aspects of the present invention. Support for these amendments is found in the specification at, for example, page 30, line 4 to page 31, line 18; and page 33, line 1 to page 35, line 22. No new matter has been added by these amendments.

(5-6) IDS and Drawings

The Applicants wish to thank Examiner Channavajjala for noting the IDS is in compliance with provisions of 37 C.F.R. 1.97 and that the drawings are acceptable for examination purposes.

(7-16) Rejection Under 35 U.S.C. § 102(e) Kazar

As noted above, the Examiner rejected claims 1-25 under 35 U.S.C. §102(e) as being anticipated by Kazar et al (U.S. Pub No. 2002/0112022) (Hereinafter "Kazar"). The Examiner cites 35 U.S.C. § 102(e) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the rejected claims as being anticipated by Kazar.[1] The Applicants respectfully assert that the

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[1] See MPEP §2131 (Emphasis Added) "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim."

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elements in the amended independent claims 1, 7, 13 and 19 related to "ditto addresses," as defined by the pending claims, are not taught or disclosed by Kazar. Accordingly, the present invention distinguishes over Kazar for at least this reason. The Applicants respectfully submit that the Examiner's rejection under 35 U.S.C. § 102(e) has been overcome.

Independent claims 1, 7, 13, 19, and 24 have been amended to more clearly distinguish over Kazar. Preferred Embodiments of the present invention provide an improved apparatus, computer-readable medium and method for providing file system snapshots that provide advantages over the prior art systems, such as that taught by Kazar. The prior art snapshot systems, such as those described in the Kazar reference, create snapshot datasets that contain inodes that are copied over from the inodes of the original file system (e.g., "creating a clone of an inode sharing all data and indirect blocks."). Kazar, page 2, paragraph 0025. This structure results in snapshots that have inodes that refer to data blocks in the original file system if those data blocks have not changed since the snapshot was captured. In addition to the inodes of the snapshot referring to the data block in the original file system, the inodes of the original file system of these prior art snapshot systems also point to the same data block. The characteristic of these prior art systems that copy the entire inode structure into the snapshot when the snapshot is initially captured, however, results in multiple inodes pointing to a particular data block. This characteristic is shown, for example, in FIG. 5 of Kazar and is described in Kazar at page 4, paragraph 0070. Having these multiple inodes that point to the same data block requires housekeeping processing overhead to, for example, determine when it is permissible to free a data block when a particular file descriptor, and its associated inode, is deleted. This housekeeping processing overhead is described in Kazar at, for example, page 4, paragraph 0071-0073.

The preferred embodiments of the present invention ensure that only one inode points to a particular data block by placing "indirect references," referred to as "ditto addresses," in all but one inode. The preferred embodiments place "ditto addresses" into all snapshot inodes except the inode of the original file system or the most recent

snapshot that contains a particular data block prior to that data block's modification in the original file system. Specification, page 28, lines 16-24 and page 34, lines 4-26.

In contrast to the prior art snapshot system described above and taught by the Kazar reference, the preferred embodiments of <u>the present invention create snapshots</u> in a manner <u>that ensures that a particular data block</u> within either the original file system or all of the snapshots <u>is only referenced by one inode</u>. The use of "ditto addresses," as claimed for the present invention, inherently provides this characteristic. This characteristic of the present invention advantageously reduces the housekeeping processing overhead that is associated with maintaining multiple inodes that all point to the same data block.

The operation of the preferred embodiments of the present invention, for example as set forth in independent method claim 1, begins by:

> <u>creating an initial</u> snapshot dataset for a source file <u>having at least one of metadata and data</u> in a file system, wherein the <u>initial</u> snapshot dataset contains substantially no data and no metadata

This processing step in the preferred embodiment only requires that an inode, in the active file system, be established for what the specification refers to as a "shadow inode file," which is an inode file for the snapshot dataset. This does not involve the allocation of data block for either the shadow inode file or for other elements of the snapshot dataset. Specification, page 18, line 16 through page 19, line 18.

The Applicants respectfully assert that this is different than the snapshot capture processing taught by the Kazar reference. Applicants respectfully assert that Kazar teaches that "When a clone is <u>created, each file's inode is copied</u>, with the result that the copied inode points to the same data blocks as the original." Kazar, paragraph 0069 (Emphasis added). This passage clearly indicates that <u>cloned</u> volumes contain a complete set of inodes as soon as they are created. The present invention overcomes this requirement to create a new inode clone by "creating an initial snapshot dataset for

a source file having at least one of metadata and data in a file system, wherein the initial snapshot dataset contains substantially no data and no metadata" as is claimed for these independent claims. Further, the Applicants further respectfully assert that the specification of "a source file having at least one of metadata and data" for the claimed invention prevents an interpretation of the Kazar reference that would anticipate this limitation by teaching or suggestion creating an empty snapshot dataset. Since the source file in the file system has "at least one of metadata and data," the system of Kazar would create a snapshot with a copy of the inode for that file and therefore could not be empty. The Applicants respectfully assert that this is quite different from the claimed invention.

After the creation of the initial snapshot by the preferred embodiment of the present invention, file system operations continue. The operation of the preferred embodiment that captures a snapshot by only establishing an inode for the shadow inode file advantageously results in only blocking access to the file system for a short time. Specification, page 19, lines 20-26.

One example of the continuing file system operations is modifying metadata within an inode of the active or original file system. Specification, page 20, lines 19-27. As set forth in, for example, the rest of independent method claim 1 which also includes the following limitations in addition to those listed above, updating metadata in the original file system includes:

> accepting, subsequent to the creating, a command to modify metadata in a second inode within the source file;
> copying, in response to accepting the command to modify metadata, at least a portion of the metadata within the second inode into a first inode within the snapshot dataset; and
> storing, in response to the accepting, disk address values into the first inode that are equal to a ditto address, the ditto address indicating that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot.

In this processing, the original inode data is copied from an original file system inode,

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which is referred to as the second inode in the above claim language, to an inode in the previously created snapshot dataset, which is referred to above as the first inode. Since only metadata was modified in this scenario, the original data block is left untouched in the original file system. Since the original data block remains in the original file system, the inode of the original file system continues to point to that data block. The operation of the preferred embodiment of the present invention, in contrast to the teachings of Kazar, stores "a <u>ditto address</u>, the ditto address <u>indicating that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot</u>" into the inode within the snapshot dataset. Specification, page 20, line 19 to page 21, line 19; and page 28, line 16-24. The operation of the present invention uses this "ditto address" to indicate that the actual data block address is contained in a later snapshot or in the original file system, as is set forth in, for example, dependent claim 4. page 28, lines 16-24.

The Applicants respectfully assert that the teachings of Kazar, taken either alone or in combination with the other cited prior art of record, fail to teach or suggest "a ditto address, <u>the ditto address indicating that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot</u>" as is claimed for the present invention. The Applicants respectfully point out that claim 1 has been rejected under 35 U.S.C. § 102(e) and a proper rejection requires that a <u>single reference teach</u> (i.e., <u>identically describe</u>) each and every element of the rejected claims. The Applicants respectfully assert that the Kazar reference does not meet this standard.

With regards to claim 2, which is directed to processing performed in response to appending data to a file in the active file system, the Applicants assert that the <u>storing</u> of "disk address values into the first inode <u>equal to the ditto address</u> to indicate that the disk address <u>is stored in one of an inode of the file system and a subsequent snapshot</u>" is not taught or suggested by the Kazar reference, taken either alone or in combination with the other prior art of reference. Kazar simply teaches copying inode data and does <u>not</u> teach or discuss copying metadata from a source file system inode and then

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copying a "ditto" address or its equivalent in the newly created inode. The Applicants further assert that, under the operational scenario of claim 2, the copying of inode data from the active file system to a snapshot according to the Kazar reference would only copy valid disk addresses because amended claim 2, which depends from amended claim 1, is processing "a source file having at least one of metadata and data" and therefore would have inodes that have disk addresses that would reference valid data blocks in the active file system. This inode data, which include valid disk addresses of data blocks in the original file system, would be copied into the snapshot in association with appending data to the active file system.

Data Retrieval

Retrieval of data from a snapshot dataset is set forth in, for example, dependent method claim 4. As set forth in amended dependent claim 4, the ditto address indicates an invalid disk address and the data retrieval processing begins by:

> accessing the first inode of the snapshot dataset corresponding to the source file;
> determining whether the first inode includes a valid disk address;

As set forth above, when accessing data in a snapshot, the inode of the snapshot is accessed and examined to determine if the snapshot inode contains a ditto address. The data retrieval processing set forth in, for example, dependent method claim 4, continues by:

> reading, in response to determining that the first inode includes a valid disk address, a data block referenced by the disk address; and
> retrieving, in response to determining that the first inode includes the ditto address, the second inode of the source file and retrieving a data block referenced by a disk address in the second inode of the source file.

As set forth above, if the inode in the snapshot, i.e., the first inode, contains a valid disk address, the associated data block is in the snapshot dataset and is accessed using that valid disk address. If, however, the inode within the snapshot, i.e., the first inode,

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contains the ditto address, the data block is in the original file system and is accessed by the disk address referenced in the second inode, i.e., the inode of the active or original file system. Specification, page 28, line 16 to page 29, line 8.

The Applicants respectfully assert that the teachings of Kazar, either alone or in combination with the other prior art of record, do not teach or suggest data retrieval processing as set forth by the last two limitations of dependent method claim 4. The teachings of Kazar require the inodes of the snapshot to contain the actual disk address of the data block being referenced, even if that data block is still in the active file system and is also referenced by at least the inode of the active file system. The teachings of Kazar require multiple actual references to the same data block, i.e., actual disk addresses of the data block in both the inodes of the snapshot and of the active file system, if that data block is shared by the snapshot and the active file system. Maintaining these multiple actual disk address references is obviated in the preferred embodiment of the present invention by storing indirect addresses, i.e., "ditto addresses," in the inodes of snapshots, i.e., the first inode as recited by the claims, if the data block is shared by the snapshot and the active or original file system. The processing set forth in dependent claim 4 is used to process this snapshot structure. The Applicants respectfully assert that the Kazar reference, either taken alone or in combination with the other cited prior art references, does not teach or suggest this snapshot structure, and therefore does not teach processing for this snapshot data structure.

The Applicants respectfully assert that the snapshots of the presently claimed invention differ from prior art implementations by advantageously ensuring that there is only one inode that refers to any particular data block. The present invention utilizes inferred logical references, which are indicated by the use of "ditto" addresses in the inodes of the snapshot dataset, when a physical reference to the original data block is not stored in that inode, but rather is to be determined by referring to an inode of a subsequent snapshot or the active file system. The use of logical references in the claimed invention overcomes problems with prior art in general, and Kazar in particular, where

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only physical references are used in snapshot datasets. Physical references, unlike the ditto addresses of the implied references of the present invention, are limited to specific hardware constraints such as disk size. The use of logical references by the claimed invention also permits the re-mapping of storage locations to newly added disk space. The logical references that include ditto addresses of the present invention further obviate the requirement to store the physical disk address of each data block in the inodes of all of the system snapshots, as is required for prior art systems and explicitly taught in Kazar.

With regards to amended claims 7, 13, 8, 14, 10 and 16, Applicants point out that these are system and computer readable medium claims that correspond to claims 1, 2 and 4 discussed above. The Applicants refer to the comments above and respectfully assert that claims 7, 13, 8, 14, 10 and 16 distinguish over the cited prior art of record for at least those reasons as well.

With regards to amended independent claim 19, the Applicants respectfully assert, as was discussed above, that the prior art of record do not teach or suggest, when taken either alone or in combination with one anther, "a <u>ditto address</u> is stored first inode, the ditto address indicating that the stored disk address is an invalid disk address and indicates that the disk address is an invalid disk address" as is recited for amended claim 19, especially when considering that claim "as a whole."

With regards to claims 22 and 23, Applicants respectfully assert that the <u>ditto address</u> specified in amended claims 22 and 23 to <u>indicate an invalid disk address and that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot</u> is not taught or suggested by the prior art of record. As discussed above, Kazar and the other prior art of record is silent as to an inode <u>that has an invalid disk address and that indicates that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot</u>. As noted above, Kazar only discusses storing data block addresses in the inodes of each dataset clone, in stark contrast to the invention claimed by amended claims 22 and 23.

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With regards to claims 24 and 25, Applicants further assert that the use of a "ditto address" as recited by these claims is not taught or suggested in the prior art of record.

Additionally, Applicants note that amended dependent claims 2-6, 8-12, 14-18 and 20-25 depend from amended independent claims 1, 7, 13 and 19, respectively. As discussed above, amended independent claims 1, 7, 13 and 19 to more clearly distinguish over the cited prior art. Since dependent claims include all of the limitations of the independent claims from which they depend, Applicants further assert that amended dependent claims 2-6, 8-12, 14-18 and 20-25 also distinguish over the cited prior art as well. Therefore, Applicants respectfully assert that the Examiner's rejection under 35 U.S.C. §102(e) over Kazar should be withdrawn.

(6-13) Rejection Under 35 U.S.C. § 102(e) Lewis

As noted above, the Examiner rejected claim 26 under 35 U.S.C. §102(e) as being anticipated by Lewis et al (U.S. Pub No. 2002/0083037) (Hereinafter "Lewis"). Independent claim 26 has been amended to more clearly distinguish over Lewis. With regards to claim 26, Applicants have amended independent claim 26 to more clearly specify the restoration processing aspect of the present invention. Independent claim 26 has been amended to specify that the method includes:

> determining that there is a ditto address in the first snapshot, wherein the ditto address indicates an invalid disk address and also indicates that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot; and
> copying, in response to determining that there is a ditto disk address in the first snapshot wherein the ditto address indicates an invalid disk address, to the filesystem the inode or data block of the most recent snapshot that corresponds to an inode with the ditto disk address and that contains a valid disk address.

To begin, the Lewis reference is directed to a method and apparatus for creating a snapshot of a file system. Although the system of Lewis uses a copy-on-write mechanism, Lewis is silent as to any form of "logical addressing," such as through the

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use of "ditto" addresses, as is claimed for the present invention.

Applicants have amended independent claim 26 to more clearly specify the processing performed in restoring a snapshot to a file system, and in particular have clarified the processing performed upon encountering a "ditto" address in the snapshot being restored.   The Applicants respectfully assert that the Lewis reference, taken either alone or in combination with the cited prior art references, does not teach or suggest "determining that there is a ditto address in the first snapshot, wherein the ditto address indicates an invalid disk address and also indicates that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot" as is set forth in amended independent claim 26.   A "ditto" address is specified in amended claim 26 as indicating "an invalid disk address and also indicates that the true disk address for the actual data block is stored in one of an inode of the file system and a subsequent snapshot." Applicants assert that Lewis, and the other prior art of record, does not teach or suggest using ditto addresses, as defined by amended independent claim 26, within inodes of a snapshot in order to implement a logical address. Further, the Applicants respectfully assert that the teachings of Lewis do not include "copying, in response to determining that there is a ditto disk address in the first snapshot wherein the ditto address indicates an invalid disk address, to the filesystem the inode or data block of the most recent snapshot that corresponds to an inode with the ditto disk address and that contains a valid disk address" as is set forth in amended independent claim 26.

The Examiner correctly points out that Lewis "specifically teaches that each snapshot includes all the information related to block and is equivalent to older block from a previous active file system." Office Action, page 13, last paragraph. The Applicants have amended independent claim 26 to recite that the two copying portions of the method are performed "in response accepting the request and in response to determining that there is a ditto disk address in the first snapshot, wherein the ditto address indicates an invalid disk address." The Applicants respectfully assert that the Lewis reference does not teach copying any inode data "in response to accepting a

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request to read data from a first snapshot" as is recited for amended claim 26.

The Applicants therefore respectfully assert that amended claim 26 distinguishes over the Lewis reference and the other prior art of record and that the rejection of this claim under 35 U.S.C. §102(e) should be withdrawn.

CONCLUSION

The remaining cited references have been reviewed and are not believed to effect the patentability of the claims as amended.

In this Response, Applicants have amended certain claims. In light of the Office Action, Applicants believe these amendments serve a useful clarification purpose, and are desirable for clarification purposes, independent of patentability. Accordingly, Applicants respectfully submit that the claim amendments do not limit the range of any permissible equivalents.
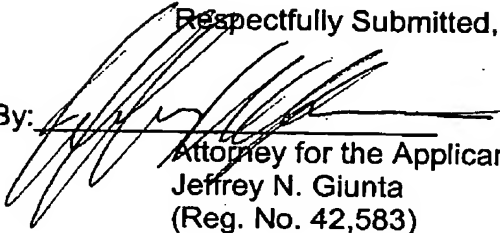
Applicants acknowledge the continuing duty of candor and good faith to disclosure of information known to be material to the examination of this application. In accordance with 37 C.F.R. § 1.56, all such information is dutifully made of record. The foreseeable equivalents of any territory surrendered by amendment is limited to the territory taught by the information of record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicants and their attorneys.

Applicants respectfully submit that all of the grounds for rejection stated in the Examiner's Office Action have been overcome, and that all claims in the application are allowable. No new matter has been added. It is believed that the application is now in condition for allowance, which allowance is respectfully requested.

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PLEASE CALL the undersigned if that would expedite the prosecution of this application.

Respectfully Submitted,

Date: March 7, 2004

By: _____

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